CHAPTER IV. THE NATIONAL GEOTHERMAL ENERGY PLAN

OVERVIEW

This section describes the roles of Federal, state, and local governments in support of national geothermal resource development strategy and goals.

The Geothermal Research, Development, and Demonstration Act of 1974 (Public Law 93-410), in assigning roles to the several agencies discussed herein, gave ERDA (now DOE) lead responsibility for the Federal geothermal program, and established interagency cooperation through the Geothermal Energy Coordination and Management Project, now the Interagency Geothermal Coordinating Council (IGCC). This body serves as the vehicle to develop a comprehensive Federal geothermal program. Since a significant number of non-DOE agencies within the Federal establishment have retained substantial responsibilities within the Federal program, coordination remains of prime importance.

Federal Policy Coordination

The Interagency Geothermal Coordinating Council is composed of representatives from several departments--Energy, Interior, Agriculture, Treasury, Commerce, Housing and Urban Development, Defense, the National Science Foundation, and the Environmental Protection Agency. Other agencies are represented on panels and working groups as the need arises.

The history and current organizational arrangements of the IGCC are detailed in Appendix A.

The IGCC coordinates various national geothermal programs. The IGCC is charged with ensuring that the missions and activities of specific Federal agencies are sufficient to meet the needs of the geothermal development in the area of resource evaluation, technology development and demonstration, and the development of commercialization strategies. The Council also provides support to the Geothermal Loan Guaranty Program.

Briefly the responsibility of the Council, in accordance with the provisions and intent of PL 93-410, is to:

> ...coordinate those Federal plans, activities, and policies which are related to or impact on geothermal energy, including ancillary activities of agencies not represented in the Council membership...The Council, through the Chairman, may make recommendations to the appropriate agencies and the President with regard to alternative policies or actions considered necessary or desirable to expedite the development and utilization of geothermal energy resources.

Five major subgroups comprise the IGCC. The Staff Committee supports the Council and manages the Panels and Working Group. The Budget and Planning Working Group coordinates budgets and general agency plans, and

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prepares the IGCC Annual Report. The Institutional Barriers Panel recommends changes in laws, governmental policy, and procedures to enhance the development of geothermal energy. The Environmental Controls Panel, newly formed this year, makes recommendations based on its evaluation of environmental concerns and regulations that may affect geothermal commercialization. The Leasing and Permitting Panel, also formed this year, evaluates legislation and regulations pertaining to geothermal leasing and permitting.

Federal Funding

Federal geothermal outlays and budgets for FY 78 through FY 81 are shown in Table IV.1. The status of the Geothermal Resource Development Fund and Guaranty Authority is presented in Table IV.2. The total budget has remained almost constant over the last three years.

Program development and modification are closely coupled with the Federal budget cycle. Implementation of new policies often means new regulations, whose development may take from one to three years, including preparation of any required environmental impact statement (EIS). New policies requiring funding but no new regulations are subject to the regular and supplemental appropriations schedules of the Congress. Only those actions that do not require significant changes in funding or in regulatory policies can be fully implemented in less than a year.

Integrated Plan

The Federal Agencies, working in cooperation with states and local governments and the private sector, seek to stimulate and support the use of geothermal energy as soon as possible. Since many parties are involved, the plan is complex and requires continued coordination. The basic responsibilities of the parties are shown in Table IV.3. Several agencies are involved with each major activity and nearly all agencies are involved with more than one activity.

Table IV.4 presents Federal responsibilities in more detail, and outlines state and local government and private activities as well.

A. FEDERAL AGENCIES

The United States Geological Survey (USGS) of the Department of the Interior (DOI), and the Division of Geothermal Energy (DGE) in DOE, maintain active programs for the exploration, assessment, and confirmation of geothermal resources. Additionally, the Water and Power Resources Service (DOI) conducts exploratory geothermal investigations and water supply studies.

The USGS conducts a continuing broad assessment of U.S. geothermal resources of all types--hydrothermal systems of various temperature ranges, geopressured zones and hot dry rock regimes. This assessment identifies regions where such resources are known or are believed to exist; determines characteristic geologic, hydrologic, geochemical, and geophysical parameters of these resources; develops scientific basis for

Table IV.1

FEDERAL FUNDING FOR GEOTHERMAL ENERGY

(in $ thousands)

ORGANIZATION UNIT	ACTUAL FY 1977	ACTUAL FY 1978	ACTUAL FY 1979	ESTIMATED FY 1980	REQUESTED FY 1981
Department of Agriculture					
U.S. Forest Service	40	678	775	750	739
Department of Defense					
Navy	758	542	924	17,100	17,800
Air Force	15	0	13	21	2,400
DOD Total	773	542	937	17,121	20,200
Department of Energy					
Energy Technology	53,326	105,962	142,637	138,428	142,000
Resource Applications			9,737	9,026	10,000
Office of Energy Res.	1,900	2,800	3,200	3,400	4,000
Environment	3,862	3,896	3,167	2,303	2,949
Geothermal Loan Guaranty Fund (Administrative Expenses)	380	410	189	1,180	1,091
DOE Total	58,468	113,068	158,930	154,534	160,040
Department of Interior					
Fish and Wildlife	200	200	200	74	74
Bureau of Land Mgmt.	2,500	2,300	2,585	2,600	2,600
Bureau of Mines	528	550	1,050	800	400
Water and Power Res.Serv.	2,557	1,800	555	910	60
Geological Survey, Geothermal Res. Program	9,384	10,184	12,043	10,092	7,569
Geological Survey, Geothermal Evaluation and Lease Regulation	1,512	1,854	2,194	1,994	1,994
DOI Total	16,681	16,888	18,627	16,470	14,423
Environmental Protection Agcy.	600	670	750	750	750
National Science Foundation	200	175	70	0	0
Total Federal Geothermal Program Budget	76,782	132,021	180,089	189,696	196,152

Table IV.2

GEOTHERMAL RESOURCES DEVELOPMENT FUND AND GUARANTY AUTHORITY

	FY 1979	
	Fund	Authority
Unexpended Appropriations, Carried Forward from FY 1978	$ 44,210,263	$
New Guaranty Authorization, FY 1980		50,000,000
FY 1979 Guaranty Authorization		300,000,000
Value of Loans Guaranteed		43,465,000
Guaranty Authorization Carried to FY 1980		306,535,000
Administrative Expenses Incurred* (1979)	496,701	
Guaranty Fees Collected in FY 1979	118,715	
Unexpended Appropriation Carried to FY 1980	$ 43,832,277	
Guaranty Fees Collected in FY 1977 and FY 1978 and Deposited in Miscellaneous Receipts	131,842	
Guaranty Fees Deposited in Miscellaneous Receipts which will be Transferred to GRDF	80,702	

*Contractor and consultant costs necessary to assist in evaluating technological, geophysical, financial, marketing, management and legal data submitted with guaranty applications and to assist in monitoring guaranteed projects.

Table IV. 3

BASIC RESPONSIBILITIES OF FEDERAL AGENCIES

Produce Energy

- DOE/RA
- DOC/EDA
- DOD
- HUD
- USDA/FmHA

Stimulate Energy Production

- DOE/RA
- DOC/EDA
- HUD
- USDA
- DOT

Support Energy Production (Institutional Aspects)

- DOE/RA
- DOE/Env
- DOE/FERC
- EPA
- DOI/BLM
- DOI/USGS
- DOI/FWS
- USDA/FS

Make Federal Geothermal Resources Available

- USDA/FS
- DOE/RA
- DOI/BLM
- DOI/USGS

Reduce Costs and Risks (Research and Development)

- DOE/RA
- DOE/ER
- DOE/Env
- EPA
- DOI/BOM
- DOI/USGS
- DOI/FWS
- DOD

Improve Resource Estimates

- DOE/RA
- DOI/USGS
- DOI/WPRS

Table IV.4

DETAILED ACTIVITIES OF FEDERAL, NON-FEDERAL AND PRIVATE SECTORS

ACTIVITY	FEDERAL AGENCY'S ROLE	STATE AND LOCAL GOVERNMENT'S ROLE	PRIVATE ROLE
PRODUCE ENERGY	DOE/RA o Guarantee Loans o Cost-Share Field Demonstration Projects	o Cost Share Projects o Construct Facilities	o Cost Share Projects o Construct Facilities
	DOC/EDA o Award Grants on Projects		o Provide Capital
	DOD o Construct Facilities For Own Use		o Provide Management
	HUD o Award Grants for Projects		
	USDA/Farmers Home Administration o Award Grants for Projects		
STIMULATE ENERGY PRODUCTION	DOE/RA o Disseminate Information o Give Technical Assistance o Award Planning Funds to States o Provide Reservoir Confirmation Assistance	o Disseminate Information o Plan o Provide Appropriate State Geothermal Rights Laws	o Broker Projects
	DOC/EDA o Award Grants for Planning	o Provide Tax Incentives	
	HUD o Allocate Planning Funds		
	USDA o Allocate Planning Funds		
	DOT o Administer Tax Incentives		

Table IV.4 (Cont.)

ACTIVITY	FEDERAL AGENCY'S ROLE	STATE AND LOCAL GOVERNMENT'S ROLE	PRIVATE ROLE
SUPPORT ENERGY PRODUCTION (INSTITUTIONAL ASPECTS)	DOE/RA o Provide Environmental Assessments and Impact Statements on DOE Projects (including Loan Guarantee Projects) o Make Recommendations on New Legislation o Facilitate International Technology Exchange DOE/Environment o Review EAR's and EIS's o Write Environmental Development Plans o Write Area Environmental Assessments DOE/FERC o Issue Power Production Decisions on Geothermal Power Projects EPA o Formulate Environmental Regulations DOI/BLM o Undertake Environmental Reviews before Leasing DOE/USGS o Monitor Environmental Impacts after Leasing DOI/FWS o Provide Environmental Reviews as Requested by DOE, BLM, USGS, and FS	o Formulate State Environment Regulations o Issue Required Permits and Approvals o Formulate Public Utility Commission Regulations and Decisions o Cooperate with Federal Environmental Review Processes o Cooperate with Federal Permitting Procedures	o Provide Environmental Data Requested o Apply for Permits and Approvals

Table IV.4 (Cont.)

ACTIVITY	FEDERAL AGENCY'S ROLE	STATE AND LOCAL GOVERNMENT'S ROLE	PRIVATE ROLE
SUPPORT ENERGY PRODUCTION (INSTITUTIONAL ASPECTS) Con't.	USDA/FS o Provide Environmental Reviews and Assessments for Forest Service Lands o Consent to Leasing on FS Lands o Review Development Permits and Approvals		
MAKE FEDERAL GEOTHERMAL RESOURCES AVAILABLE	DOE/RA o Set Production Goals o Promulgate Regulations DOI/BLM o Leasse Competitive BLM and FS land o Process Noncompetitive Lease Applications DOI/USGS o Review Development Plans o Provide Permits and Approvals o Evaluate Resource Areas to Determine Competitive Lease Sales USDA/FS o Process Noncompetitive Lease Applications o Review Permits and Approvals	o Cooperate with Federal Leasing Procedures o Issue Permits and Approvals	o Apply for Lease Applications o Bid on Competitive Leases o Meet Requirements for Permits and o and Approvals
REDUCE COSTS AND RISKS (RESEARCH DEVELOPMENT AND DEMONSTRATION)	DOE/RA o Build Hydrothermal Demonstration Plants o Undertake Materials Research and Development o Undertake Drilling Research and Development o Develop Environmental Technology o Develop Geopressured Technology o Develop Hot Dry Rock Technology o Undertake Geochemical Engineering Research and Development o Improve Reservoir Evaluation and Exploration Technology	o Conduct Research	o Conduct Research o Provide Insurance o Assume Risks

Table IV.4 (Cont.)

ACTIVITY	FEDERAL AGENCY'S ROLE	STATE AND LOCAL GOVERNMENT'S ROLE	PRIVATE ROLE
REDUCE COSTS AND RISKS (RESEARCH DEVELOPMENT AND DEMONSTRATION) Con't.	DOE/Energy Research • Perform A Basic Research DOE/Environment • Environmental Technology EPA • Develop Environmental Technology DOI/Bureau of Mines • Perform Geothermal Brine Research • Develop Standard Test Methods for Geothermal Materials • Field test Site-specific Materials DOI/USGS • Improve Resource Assessment and Exploration Concepts DOD • Perform Construction Materials/ Corrosion Research		
IMPROVE RESOURCE ESTIMATES	DOE/RA • Explore Potential of Hot Dry Rock Resources • Conduct Cost-Shared Hydrothermal Reservoir • Assessment with States DOI/USGS • Characterize various types of geothermal systems • Assess resources on a regional basis and update and refine national inventory DOI/WPRS • Explore Resources	• Conduct State Resource Assessments • Cost-share Federal Reservoir Assessments	• Conduct Reservoir Assessments • Cost-Share Federal Reservoir Confirmation • Provide Wells of Opportunity

geophysical and geochemical techniques to model these resources; and estimates geologic parameters, depths, areal extent, temperature ranges, and quantities of thermal energy. Emphasis is on the entire geothermal system encompassing one or more individual reservoirs that are the focus of DOE studies. Results provide fundamental knowledge for a better understanding of the nature, distribution, and energy potential of U.S. geothermal resources and for reliable estimates to establish national goals for geothermal energy utilization.

A major product of this assessment, USGS Circular 790, "Assessment of Geothermal Resources of the United States - 1978," was published in FY 79. This report is an update and expansion of the previous national inventory, Circular 726, published in 1975. The USGS plan includes further updated inventories of those resources for which there was scanty data in 1978, specifically low-temperature hydrothermal systems, geopressured zones outside the Gulf Coast, and hot dry rock regimes, as well as improved estimates of the undiscovered geothermal resources.

In contrast, DGE focuses its resource studies on specific prospects within the broad areas defined by the USGS. The DGE program characterizes geothermal reservoirs. The major parameters are boundaries, porosity, permeability, temperature, pressure, chemistry, productivity, and longevity. In particular, DGE reservoir definition programs involve:

- Working with industry and the states to locate and confirm hydrothermal reservoirs for electric power production and direct heat applications

- Defining the location, magnitude, and production characteristics of the substantial geopressured geothermal resources of the U.S. Gulf Coast

- Defining the locations and characteristics of attractive hot dry rock prospects.

The DGE plan also seeks improvement in the tools and techniques needed to accomplish exploration and assessment. Geoscience technology, developed primarily for hydrocarbon and mineral exploration, is often unsuitable for geothermal work, especially where high temperatures are encountered. The adaptation of geoscience equipment and techniques to geothermal conditions will improve the effectiveness and reduce the costs of geothermal reservoir definition activities. The plan for DGE is to continue the existing program at the same pace as last year. For the USGS, proposed reduction in funding would severely delay assessment of several major regions and suspend the assessment of lower temperature hydrothermal systems.

The goal of the complementary USGS and DGE program is to ensure that U.S. geothermal resources are discovered, evaluated, and characterized, and that exploration and reservoir assessment technologies are developed to increase the accuracy and reduce the costs of these activities.

The Department of Defense (DOD) recognizes the significant quantity of potential geothermal energy resources on DOD lands, and the importance

of developing these resources. However, the co-use of lands for geothermal development and military activities will be very difficult at best.

The first step in identifying the magnitude of the problem is to assess the probable size of the DOD geothermal resource holdings. Toward that end, DOD has a program of resource assessment and exploration including geologic, geophysical, and shallow well drilling. This ongoing program continues to add to the data base.

In addition, DOD has a legal-institutional program to identify and sort out the obstacles confronting both DOE and industry in the development of geothermal resources. The final output of this program, coupled with the DOD assessment program, leads to initial field development by DOD and industry for a specific field. Ideally, this initial development is under DOD's direct control, as at China Lake Naval Weapons Center (Coso, Cal.), to facilitate a good DOD/industry working agreement.

Leasing of Geothermal Resources

At present, approximately 2.8 million acres of Federal lands have been leased for geothermal development. An additional 4 million acres have been applied for and another 1.3 million acres of known geothermal resource area (KGRA) lands have yet to be offered for competitive sale. Leasing this much land will take about 5 years of leasing activity at the current pace. However, both BLM and the Forest Service have started procedures to accelerate this pace.

The exploration and development of this unleased acreage would lead to between 3,000 MW and 10,000 MW of geothermal energy on-line by the end of this century. The KGRA lands are thought to include high-quality geothermal resources. Acceleration of the rate of leasing these lands is needed to meet utilization goals.

BLM will soon implement a phased environmental review procedure as proposed by the USDA. Phased environmental review should speed leasing significantly by removing the requirement for analysis of full development before leasing. BLM is also considering establishing time and page limits for its environmental reviews, in line with Council of Environmental Quality guidelines.

Four Federal entities have leasing responsibilities: the Bureau of Land Management (DOI), the U.S. Geological Survey (DOI), the U.S. Forest Service (USDA), and the Leasing Policy Development Office (DOE).

The Department of Interior's involvement in geothermal resource development precedes DOE's by several years, dating from the passage of the Geothermal Steam Act of 1970. Leasing did not begin, however, until January 1974, after the programmatic environmental impact statement was completed.

BLM and USGS share major responsibilities within DOI. BLM sets terms and conditions for surface protection, reclamation, and adherence to various environmental laws; USGS assures compliance. BLM completes prelease environmental reviews, administers competitive lease sales, and

issues leases. USGS evaluates all parcels for KGRA designation, evaluates competitive parcels to establish minimum acceptable bids before BLM offers them for sale, approves and monitors all post-lease operations, and collects royalties.

The Fish and Wildlife Service provides biological expertise to the Federal surface management agencies (BLM, FS, and USGS) in both pre- and post-leasing phases. These actions involve biological and ecological input to environmental studies, resource assessments, recommended stipulations, mitigation practices, design and development of baseline and monitoring programs, lease selections or alternatives, and evaluations of compliance requirements.

The U.S. Forest Service's (FS) primary role is to evaluate the possible impacts of leasing in National Forests on surface resources and uses, and to develop terms and conditions to assure that those impacts are eliminated or mitigated to the maximum reasonable extent.

The Forest Service must give its consent and specify terms and conditions for geothermal leasing on National Forest System lands. Because of potential conflict between geothermal resource development and other surface uses, and because of a general low emphasis on geothermal resource development, the FS has tended to take a cautious, low-priority approach to geothermal leasing. Increased private and government interest in geothermal resources over the past two years has lead the FS to reevaluate its priorities. In recognition that decisions on leasing have been slow, the FS recently began to encourage more diligent action on lease applications within two years. Although new procedures are not fully approved and implemented, they include the following concepts:

- Leasing decisions should be made before completion of Land Management plans, unless plans are nearly complete.
- Leasing decisions must be scheduled promptly, and interested parties must be notified of reasons and expected length of any delays.
- Actions must be scheduled within certain reasonable time limits, while allowing flexibility for special circumstances.
- Interested parties will be notified of adverse decisions on leasing so that they may file appeals.

When the Department of Energy was established, certain responsibilities for energy resources on Federal lands were transferred from DOI to the Leasing Policy Development Office (LPDO) of DOE. LPDO has the responsibility to promulgate regulations which relate to the:

- Fostering of competition for Federal leases
- Implementation of alternative bidding systems

- Establishment of diligence requirements
- Setting of production rates for Federal leases
- Specifying of procedures, terms, and conditions for the acquisition and disposition of Federal royalty interests taken in kind.

Additionally, LPDO is responsible for approving the terms and conditions relevant to the above functions for leases to be issued by DOI.

A Memorandum of Understanding (MOU) between DOE and DOI was concluded in September of 1978. In accordance with this MOU, LPDO sets production goals for energy mineral resources on Federal lands to be used by DOI to determine their leasing programs and lease planning schedules. These production goals are to be revised every two years.

LPDO activities planned for FY 80 will include:

- Establish geothermal energy production goals and ensure that the leasing program and schedule developed by DOI achieves these goals
- Identify leasing and regulatory problems that hinder achieving the production goals
- Analyze and propose changes in leasing policy and regulations to promote geothermal production
- Identify geothermal areas affected by Federal land withdrawals and their potential impact on geothermal energy production
- Promulgate regulations for issuing noncompetitive leases where no bids are received on KGRA tracts offered for competitive lease.

The plan is to accelerate the pace of leasing geothermal land.

Development of Geothermal Technology

DOE's Division of Geothermal Energy (DGE) supports programs to improve the technology for energy extraction and use. DGE is responsible for the research, development, and demonstration of geopressured and hot dry rock resources, and bridges the gap between the broad geothermal resource assessment role of USGS and the role of the Division of Geothermal Resource Management (DGRM) to bring about vigorous commercial development of hydrothermal resources.

The DGE technology development program pioneers techniques, equipment, and materials for exploitation of geothermal resources; reduces the costs of the technology to make geothermal development competitive; and encourages the establishment of industry-wide standards for geothermal materials and equipment.

The emphasis this year is:

- Improved drill-bits and advanced drilling systems for use in hard rock, high temperatures, and corrosive downhole environments
- Downhole motors, seals, bearings, and pumps designed to operate under geothermal conditions
- Drilling fluids and cements adapted to high temperatures and corrosive conditions
- Stimulation technology to increase the productivity of geothermal wells and reduce the number of wells required for each geothermal plant
- Engineering technology for geothermal reservoirs to measure productivity and longevity by early testing, and to maximize energy recovery
- Advanced energy conversion systems to reduce capital costs and to enable economic exploitation of moderate-temperature reservoirs
- Technology for extracting heat from hot dry rock resources.

Additionally, the Bureau of Mines (DOI), through an interagency agreement with DOE, supports research on construction materials for handling geobrines and the corrosion behavior of iron-, nickel-, and titanium-base alloys in geothermal fluids.

Environment

The Environmental Protection Agency (EPA) has Federal responsibility for developing environmental standards and regulations. EPA has published a manual of "Pollution Control Guidance for Geothermal Energy Development" that discusses current Federal regulations bearing on geothermal commercialization and reviews the Agency's current thinking on other environmental concerns and on control options. At this time, EPA has no specific geothermal regulations in force, although existing standards and regulations limit allowable levels of pollutants in the atmosphere, receiving waters, and the land. The EPA has an internal working group that examines the need for regulations affecting geothermal energy systems and the impact of regulations on the industry.

The EPA, FWS, and DOE (EV and DGE) study the environmental issues surrounding geothermal energy use, and develop mitigating methods. Studies range from baseline environmental monitoring of potential geothermal resource areas to control technology development and demonstration. Efforts are also underway to develop data bases on which reasonable standards may be based. The Environmental Controls Panel, newly established by the IGCC and chaired by EPA, is aiding in the coordination of related environmental control efforts by EPA, DOE, USDA, and DOI.

In FY 79, EPA assumed the mandate formerly exercised by the Council on Environmental Quality (CEQ) to oversee the environmental aspects of Federal non-nuclear energy research. In addition, the EPA conducts research on all matters of environmental concern.

The Fish and Wildlife Service (FWS) has responsibilities for the management and wise use of the nation's fish and wildlife resources and the habitats upon which these resources depend. Particular responsibilities include migratory birds, certain marine species, endangered and threatened animal and plant species, and protection and management of the National Wildlife Refuge System.

The objective of the Service's program is to conserve, protect and enhance fish and wildlife and their habitat and facilitate balanced development of geothermal resources by timely and effective provision of fish and wildlife information and recommendations.

The Fish and Wildlife Service's primary role is to provide continuing biological assistance and technical support to other Federal agencies, State and local governments, and private industry, and assist them in developing an ecologically sound industry.

To meet these mandated responsibilities, the Service conducts programs to:

- Develop ecological information and techniques to be used to facilitate environmentally balanced geothermal development programs
- Identify specific impacts on fish and wildlife resources and techniques to minimize adverse impacts
- Provide technical support to other Federal agencies to insure adequate consideration of fish and wildlife resources in energy development considerations.

The role of DOE's Assistant Secretary for Environment (ASEV) is to ensure that development and commercialization of geothermal energy is environmentally and socially acceptable, with minimal risk to health and safety. Included in the mission are activities that:

- Conduct R&D projects concerning environment, health, and safety
- Perform systems assessment and policy analysis of geothermal development from environmental, health, and safety perspectives
- Assure that DOE geothermal programs comply with environmental and safety laws, regulations, and policies.

The Assistant Secretary also regularly updates an Environmental Development Plan, which details environmental concerns and the R&D

necessary to meet those concerns. The Environmental Protection Agency, in turn, assesses the sufficiency and timeliness of ASEV's R&D activities and recommends additional studies as needed.

The USGS, as a part of its resource studies, analyzes geohydrological data to gain a fundamental understanding of the processes that result in subsidence and increased seismic activity due to geothermal development.

The Water Resources Council (WRC) assesses water resource requirements and water supply availability in commercial applications of energy technologies. As a precondition of Federal assistance, WRC provides DOE with site-specific assessments of water use and evaluations of the environmental, social, and economic impacts of the dedication of water resources for commercial application.

The plan is to continue to assess the need for environmental regulations, and, if needed, to process them quickly.

Hydrothermal Resource Commercialization

Following an extensive review within DOE in 1978, hydrothermal technology was deemed ready for active commercialization. To help private industry develop this resource, the Division of Geothermal Resource Management (DGRM) was established under the Assistant Secretary for Resource Applications of DOE. DGRM identifies those market sectors and localities that could benefit most from geothermal energy. It conducts feasibility studies and provides technical assistance to states and industry to encourage the rapid use of the hydrothermal resource.

Authorized by the Energy Tax Act of 1978 and 1979, the program provides tax incentives to developers and users. To complement these tax incentives, DGRM supports a three-phased program to stimulate initial geothermal development. This first phase consists of a forgivable loan or grant program (for nonelectric use) to finance the drilling of the first well in a new area. Uncertainty about the quality of the resource and costs of the first well are often major deterrents to initial development, and such a loan program reduces that risk to developers. The second phase provides for the cost-sharing of economic and technical feasibility studies for specific geothermal applications. These studies will supply the information needed by potential users to make decisions regarding their investments in geothermal energy. The third phase provides loan guarantees to support the construction of facilities.

Another major program supports development through the widespread and aggressive dispersion of information about geothermal energy and through the provision of technical assistance by regional contractors.

The Federal Energy Regulatory Commission of the Department of Energy, while having no statutory functions in geothermal development, is concerned with regulatory and policy development activities that can reduce the impacts of near-term energy shortages. In this function, it conducts programs to overcome institutional barriers to geothermal commercialization.

DOE's Division of Geothermal Energy (DGE) provides hydrothermal commercialization support through the following methods.

Demonstration, Pilot, and Experimental Facilities. Demonstration plants, generally built at commercial scale, confirm full technical feasibility of systems for generating electric power from geothermal reservoirs; provide economic data for capital and operating expenses of plants under commercial conditions; and test the capacity of institutional and regulatory climates to accommodate commercial geothermal development. DGE demonstration plants are cost-shared by government and industry. Their operation provides valuable "hands-on" experience to a growing industry and lends credibility to the technical, economic, and institutional data generated by each plant.

Pilot plants, built at a subcommercial scale, establish the technical feasibility of advanced concepts and provide information on economics of operating the plants. Although industry involvement in such projects is welcomed, DGE does not expect equal cost- and risk-sharing by industry.

Experimental facilities provide realistic field conditions for tests of components, materials, systems, and techniques intended for commercial service. These facilities are available to both government and industry clients.

Direct Heat Applications Experiments. Few major technical barriers impede the commercial exploitation of geothermal resources for the space heating, industrial processing, or agricultural purposes. Rather, unfamiliarity of industry with these resources retards the rate of their development. To overcome this obstacle and to provide real-world data on system design, performance, and economics, DGE supports a substantial number of demonstration experiments which utilize geothermal heat for practical results. In general, each nonelectric experiment is a self-contained unit much smaller than a geothermal electric power plant. Support for such projects is determined on a competitive basis. Although user cost-sharing is required, the government pays the largest portion of the cost. All of the direct heat demonstrations are user-operated.

The emphasis on stimulating early development is supported by cooperative efforts of the Departments of Energy, Interior, and Agriculture to identify and lease high-priority geothermal areas located on Federal lands. A recent DOE/DOI Memorandum of Understanding required that DOE establish goals for production from Federal lands and that DOE facilitate leasing of the necessary resources.

Geopressured Resource Studies

DOE's Division of Geothermal Energy (DGE) has the lead role in determining the technical, economic, and environmental feasibility of extracting methane, electricity, and end-use heat from the geopressured geothermal resource on the Gulf Coast of Louisiana and Texas. The program concentrates on flow tests of wells drilled into geopressured reservoirs. Within the next three years, these flow tests will provide enough knowledge to determine whether extraction of energy from geopressured formations is commercially feasible.

DGE works closely with USGS's geopressured resource assessment program in developing the broad geohydrological framework to define the occurrence of these resources, and in analyzing the legal, economic, and institutional framework for development. These analyses form the basis for resource development scenarios. Studies of legal issues and potential markets are continuing.

Extensive geopressured resource definition is in progress. The description of the geopressured aquifers is based on geophysical logs from wells originally drilled for oil and gas, on flow tests of a few existing wells, and on tests of new wells in the most promising geopressured aquifers. The new wells will be designed to handle high rates of fluid production during long-term tests. The interpretation of logs and flow tests is accompanied by analytical models of fluid properties and methane production from these reservoirs.

DGE is conducting studies of possible environmental effects, particularly of land subsidence and induced seismicity, from sustained high-volume production of geopressured brine. Injection as a means of disposing of geopressured fluids is also being studied. Environmental assessment and monitoring of well sites in Louisiana and Texas will be accelerated to keep pace with the geopressured drilling and flow tests.

Hot Dry Rock Resource Studies

DGE has responsibility for evaluating the nationwide potential for application of the hot dry rock (HDR) technology and for supporting the development of new technical approaches for extracting energy from this source. The major objectives of the DGE program are 1) to determine the potential of the HDR resource, 2) to determine the potential for widespread use of the HDR resource, and 3) to effect commercial exploitation of this resource before the year 2000. Technical and economic feasibility studies to be undertaken through 1986 will determine the scope of DGE's future development efforts. DGE evaluates areas and sites throughout the country where HDR energy extraction technology could be applied.

A memorandum of understanding between DGE and the USGS provides for geological and geophysical studies to determine hot dry rock resource potential. Feasibility studies investigate HDR heat extraction techniques. High-temperature materials and equipment are developed and tested, along with upgrading of downhole instrumentation and commercial drilling techniques. Experiments with techniques designed to extract thermal energy from HDR deposits are conducted in the field. The first experimental site is at Fenton Hill, N.M.

Federal Tax Policy

In developing and implementing Federal tax policies, the Department of the Treasury has a significant impact on the commercial utilization of geothermal resources.

Tax incentives, in the form of intangible drilling cost deductions and a depletion allowance, were included in congressionally proposed energy legislation, which became the National Energy Act (NEA) of 1978.

The NEA eliminated what had been the principal deterrent to investment in geothermal resource development projects, that is, uncertain tax treatment. The NEA explicitly authorizes intangible drilling cost deductions and a percentage depletion allowance for geothermal resources, and provides tax credits through 1984 for residential and business users of geothermal energy, with the exception of public utilities. It allows deregulation of geopressured methane and gives the Federal Energy Regulatory Commission (FERC) certain powers to order wheeling and interconnection for electricity from geothermal plants, and to exempt geothermal plants that qualify as cogenerators or small-power producers from public utility regulation. These provisions have resulted, for the first time, in substantial attention within the financial community to investment in geothermal projects.

The Department of Energy is authorized to conduct continued research and make recommendations in the area of Federal tax policy.

B. STATES

While state activities are too detailed to enumerate here, each state with a significant potential for geothermal energy development must fulfill and coordinate a number of development and regulatory roles for development to take place. These include:

- Issuing state permits for exploration and development
- Examining existing state legislation to determine applicability to geothermal development
- Evaluating and authorizing state-level tax incentives for geothermal development
- Resolving water and mineral rights and regulatory issues where laws designed for other resource uses do not include or actually impede geothermal development
- Coordinating state and local activities to discover and develop the most beneficial uses and sites for geothermal development
- Anticipating and monitoring environmental and use impacts of geothermal development to ensure that these comply with state regulations
- Interacting with the Federal government to ensure that Federal policies and regulations will be beneficial to geothermal development in each state
- Providing funds to meet cost-sharing requirements of Federal field demonstration projects.

The states can obtain assistance from DOE by obtaining contract and grant funds for state and site-specific planning. Additional funds are available to cost-share with the states in reservoir assessment projects.

C. LOCAL GOVERNMENTS

County and city governments promote suitable development of geothermal energy use within their local domains while balancing requirements for geothermal development with other local needs. This can be accomplished in many cases by including geothermal elements in a community's master development plan.

One instance where local government leadership is especially valuable is in the promotion of centralized geothermal district heating systems. Based on experience in Iceland and Europe, these systems are very desirable when a sufficient amount of heat use is available from a common well or set of wells. To start such a system economically, usually one of two large buildings must be connected at the outset. Municipal office buildings, schools, and civic centers can provide the nucleus, with smaller users connecting to the system after its reliability and economics have been demonstrated.

Municipal utility staff are usually familiar with the simple technology used in geothermal direct heat systems, and municipal bonds can finance such projects advantageously. Local governments can and have been finding start-up help with DOE funds for feasibility studies, and cost-shared development of feasible projects. Substantial technical assistance is also available on a much more informal basis from DOE-supported regional centers.

D. PRIVATE SECTOR

The private sector is the primary focus of geothermal energy development. It is here that most specific projects are conceived, financed, and built. The many active roles of the private sector include: investment, exploration, field development through drilling, sale of steam, purchase of steam and hot water, operation of electric plants, improvement of drilling equipment, and provision of reservoir insurance. Federal and state sponsored geothermal activities are intended to foster an active private sector geothermal industry, rather than compete with it.

The most noticeable activities in the private sector center around continued development of The Geysers field and the beginnings of geothermal electric development at sites in the Imperial Valley, California. Near-term potential shortfalls in electricity supply in California will provide a strong impetus for continued geothermal resource development.

The private sector also influences the Federal program by providing members for the Geothermal Subcommittee of the Energy Research Advisory Board. This Committee reviews the plans for the Federal program and advises the Secretary of Energy on the program.

Geothermal Test Well Locations